# Independent Peer Review of the California High-Speed Rail Ridership and Revenue Forecasting Process

Findings and Recommendations from the April-June 2013 Review Period

November 22, 2013

The Peer Review Panel held its ninth formal meeting on June 20-21, 2013 at the Parsons Brinckerhoff offices in San Francisco. The Panel also conducted discussions via electronic mail, teleconference, and videoconferencing both before and after this meeting. This report covers their activities and deliberations from May through June 2013. The panelists include:

- Frank S. Koppelman, PhD, Professor Emeritus of Civil Engineering, Northwestern University (chair)

- Kay W. Axhausen, Dr.Ing., Professor, Institute for Transport Planning and Systems, ETH Zurich (Swiss Federal Institute of Technology Zurich)

- Eric Miller, PhD, Professor, Department of Civil Engineering, University of Toronto

- David Ory, PhD, Principal Planner/Analyst, Metropolitan Transportation Commission

- Kenneth A. Small, PhD, Professor Emeritus, Department of Economics, University of California-Irvine

All panelists were present in person for the meeting. Rick Donnelly, PhD, of Parsons Brinckerhoff (PB) served as facilitator and recorder for the Panel. The meeting was closed to non-members.


# 1 Revised Version Numbering

The Authority and Board has adopted a new numbering version for the modeling system. Beginning in this report the Panel will adhere to the new numbering system, which is summarized in Table 1.


Table 1: Revised model system version numbering

| New version | Old version | Description |
|---|---|---|
| 1 | 1.0 – 1.1 | The original modeling system as described in the model documentation currently available on the Authority's website, and used for all forecasting work up to and including the 2012 Business Plan. |
| 2 | 1.3 | Version 1 model architecture; re-estimated using updated 2005 RP-SP survey data and final (unexpanded) CHTS data.  Calibration will use CS expansion of CHTS data based on matching 2010 socioeconomic summaries for calibration control totals.  This model will be used for the 2014 Business Plan forecasts and related work. |
| — | 1.5 | Original model specified by the Panel for use in the 2014 Business Plan, based upon assumption that the 2013 RP-SP survey results would be available and used to re-estimate all long-distance model components. This concept has been abandoned. |
| 3[a] | 2 | A new model structure based upon a revised architecture, data, expanded analytical requirements.  The models will be estimated using updated 2005 RP-SP survey data, final CHTS data, and substantial new data (2013 RP-SP surveys).  Calibration will use "population synthesis-based" expansion factors of CHTS data to 2010 for calibration control totals.  Several broad capabilities are described in the Panel's fourth report, but a definitive design has not yet been completed. |

a. Future development of the model may be split over several versions (i.e., Versions 4, 5, etc.).

## 2   Air Passenger Survey Questionnaire Review

The Panel reviewed several draft memos on the design of the air passenger questionnaire for the 2013 stated preference (SP) survey. Cambridge Systematics (CS) had submitted them to the Panel in the two months prior to the meeting. Some preliminary comments from individual panelists had already been shared with the CS staff prior to the meeting. During the meeting a list of points considered most important for CS to include the final design of the survey were compiled:

- The Panel will refine text in Section I (description of the HSR system) at its next meeting. It is important to remove any text that is irrelevant for interpreting the questions. Examples include descriptions of the Authority, description of the overall system or its benefits, or other material that does not describe the choice currently under consideration.

- The Panel wishes to review the experimental design before it is finalized. Of particular concern is an understanding of what interaction effects, if any, the survey has been designed to capture.

These points do not distract from what the Panel believes is a survey that otherwise reads very well. The Panel feels that it has been through enough iterations of review to move forward with it.

## 3   Proposed Version 2 Model Revisions

The majority of the meeting was devoted to reviewing several documents that described the model re-development work CS had completed to date. All model components have been reviewed, with initial estimation results presented for each.

### 3.1   Trip frequency model

The trip frequency model has been extensively revised in light of the preliminary data from the California Household Travel Survey (CHTS). The Panel's review of the initial model estimation revealed reasonable and intuitive results. The very large alternative-specific constants in the model were considered appropriate, reflecting the fact that long-distance trips are infrequently made compared to local ones. However, a complete review must await additional documentation, to include:

- Descriptive statistics of the variables used in the estimation, to include histograms of their distributions and spatial distribution of the residuals

- Aggregate trip statistics

- Analyses of trip induction sensitivities (induced demand) implied by the model

- A comparison of the number of long-distance trips recorded in the CHTS daily diaries compared to those found in the retrospective survey used in model estimation

The Panel appreciates that this is a difficult model to construct given the complexities of working with multiple datasets. The Panel is satisfied overall with the approach and results obtained to date, subject to the documentation requested above, given the schedule and data constraints.

## 3.2 Destination Choice Model

The Panel reviewed two sets of initial estimation results for the destination choice model. It is clear that considerable effort has gone into the update of this model component. The estimations were completed using existing mode choice logsums as a measure of separation, rather than trip distance or transforms thereof. This has implications for the interpretation of the model results and subsequent calibration. The Panel discussed this and other issues, identifying several that should be addressed before further work is submitted for review:

- Readers will struggle to understand the definition of the size variables used in the model without inclusion of the full equations for them and associated confidence intervals from their estimation. An explanation of why the terms that were included were selected is needed.

- It is unclear how the model will be adjusted to match observed trip length frequency distributions if a distance term is not included. In theory the logsums should be related to distance, but there is ample evidence from urban destination choice models that they do not perform well as a surrogate for it. It is unclear why CS believes this approach will work better in this case.

- The C2 model (for commuters) reported in their estimation results is viewed as superior to the C1 model. In general, the Panel suggests the inclusion of both distance and logsums using a piecewise linear (spline) function for distance. This will result in a more flexible model form for calibration. It will be especially important to re-estimate the logsum coefficients with updated logsums when they become available.

- Shopping trips appear to be inexplicably omitted from the model.

- An explanation of why the log of employment was included in addition to employment in the size terms should be provided, as well as how they are interpreted.

- The definition of a central business district (CBD) purely in terms of density may not be ideal. It should be contiguous, and the Panel suggests adopting the CBD definitions used by the Southern California Association of Governments (SCAG) and the Metropolitan Transportation Commission (MTC) in their regional travel models. Cliff effects attributable to CBD definition are not thought to be a significant issue.

The Panel would like to see these points addressed before this model can be finalized. As noted, the Panel assumes that the trip frequency and destination choice models will be re-estimated after the lower-level models are completed and new logsums are obtained.

## 3.3 Access/Egress Mode Choice Models

The access-egress mode choice models were simultaneously estimated with the main mode choice models. The latter are described in the following section, but some common themes pervade both. The Panel feels that for the most part this work has proceeding satisfactorily, but a few concerns remain:

- Reliability cannot be measured with sufficient accuracy with available data so as to accurately measure its effect on mode choice separately from travel time. The Panel feels that it is best to simply drop all reliability variables. While the CS argument that it is an important variable for policy analyses is convincing, its use in this case appears limited

given the imprecision of estimating the coefficient. The overall absolute size of the parameters will result in very small impacts of policy changes, but this may be due to the inaccuracy in measuring the variable rather than to a real lack of impact of reliability. Therefore, including the variable in order to facilitate policy analysis may in fact result in a mistakenly small predicted effect of reliability improvements.

- It is understood that a non-linear representation of in-vehicle time (IVT) was not evaluated due to time constraints. A non-linear approach is generally significant and consistent with theory. While the overall 2012 tests on IVT time might have been inconclusive, other tests done at the same time did indicate a plausible non-linear effect of cost. A smooth non-linear, log, or Box-Cox transformation is generally preferred. The Panel recommends that this be evaluated.

- A non-linear influence of IVT, if specified for both access/egress mode and main mode, might cause the ratio of coefficients of access/egress time to main mode time to behave more in line with expectations without having to constrain it. If it remains necessary to constrain the ratio of access/egress time to main mode time, it might better be constrained to a value as high as 1.5. Sensitivity analyses over the range of 1.1 to 1.5 should be carried out and interpreted to determine an appropriate ratio.

- It was concluded that the manner of representing the trips in production-attraction format (i.e., treating the home end as access and the other end as egress, even for the return trip) is correct and consistent.

- It appears that out-of-vehicle time (OVT) is correctly defined, but a clearer and more complete definition is needed to ensure that. How wait time for transit as an access/egress mode was calculated is of particular importance (e.g., half the headway, or something more sophisticated?).

- Prior model estimation results shared with the Panel in 2012 suggested that a non-linear representation of OVT resulted in better fits, a finding validated by experience elsewhere. The Panel was surprised that a linear form was used in this model, although recognizes that non-linear forms remain to be tested. The Panel would like more insight into whether they were tested, and if so, the results obtained.

- The method of representing the disutility of OVT as a multiple of IVT appears reasonable. A more refined approach, if data were sufficiently detailed to support it, would treat components of OVT separately and measure disutility of each (or of the observable factors that determine them, such as headway). It is understood that transfer time is included in IVT within the main mode, but that terminal and initial wait times for the main mode are included in the constant. For access/egress, initial headway might fit non-linearly (i.e., rather than defining OVT as half the initial headway), and transfer time might have it own coefficient. Including the latter as part of IVT is unusual. If transfer time is simply lumped in with IVT it is especially important to test whether the number of transfers has a separate negative effect on access/egress mode choice. Moreover, the headway at the interchange needs to be treated separately from headway at the first boarding. The former captures risk and overall reliability, but is generally not modeled (transfer, transfer wait time, and transfer walk time are instead used in various combinations).

- A test of a separate transfer penalty should be carried out and reported to the Panel if there are enough observations with transfers for this to be undertaken. It is assumed that

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the number of transfers is recorded during the skimming process for access/egress trips by transit, enabling this to be addressed.

- As previously discussed, the Panel believes that park-and-ride (PNR) and kiss-and-ride (KNR) modes of access should be combined into a single alternative, given that they are combined in one survey but not the other, so that observations do not have to be deleted from the dataset. It is understood that the Authority wishes to evaluate PNR versus KNR is some scenarios. A consolidated mode (K+PNR) can be created with parameter estimates for KNR, PNR, and K+PNR. The K+PNR constant can be proportionately allocated to the other two as an approximation.

## 3.4   Main Mode Choice Model

The joint estimation of access-egress and main mode choice is considered to be superior to separate estimation, as noted in previous reports. The Panel appreciates the work that CS has carried out to undertake the more difficult and complex estimation required. The Panel is pleased overall with the progress to date, as noted in the previous section. Several issues with the work presented include:

- The current estimation procedure does not acknowledge the existence of correlation in SP observations. This effect must be accounted for. Options for doing this include using differential weighting of the revealed preference (RP) and SP datasets, or use of a standard SP panel correction procedure. The Panel prefers the latter approach.

- The estimated models do not include inertia variables to capture the reality that SP choices may be influenced by the RP choice. This is standard practice in SP-RP studies, and must be addressed in the final model estimation.

- A decision must be made about how to interpret the separate alternative-specific constants (ASC) for RP and SP data when applying the model. It is recommended that the RP values be used for this purpose.

The Panel also discussed strategies for setting the ASC constant for HSR, which is a key issue. It is assumed that a procedure similar to that used in the Version 1 modeling system will be used. If the modeling team has confidence in the ASCs for conventional rail, their difference (i.e., RP ASC minus SP ASC) can be used to adjust the SP ASC measured for HSR from the SP experiments. It is noted that this will imply a fairly large downward adjustment to the ASC for HSR. This follows from the fact that there is a reversal of the ranking order of air and conventional rail between the two data sets. In the SP data the ASC for rail is greater than that for air, whereas the reverse is true in the RP data. This issue is important, for unlike other modes the ASC for HSR cannot be set directly during calibration. Rather, it will have to be adjusted to maintain some pre-determined relationship to the other ASCs.

## 3.5   Model Calibration and Validation

Documentation about the proposed calibration and validation approach arrived too late to be discussed during the meeting. The Panel has only completed a cursory review to date, and will forward additional comments when their review is complete. A first reading of the document suggests that it appears to be complete. However, the plan does not appear to allow for feedback between validation and calibration, which is standard practice. The panel is also concerned that

the proposed calibration and validation approach is highly ambitious given the short time frame available.

The Panel recommended a combinatorial validation approach in their sixth report (September to December 2012) that should be revisited. In particular the Panel is keen to have the comparative analyses described in Table 2 carried out, in order to understand the source of any differences in forecasts for the 2014 Business Plan and those for the 2012 Business Plan. Table 2 has been updated to the current model naming conventions and data availability. The two validation tests shown should be completed before the Version 2 model is used to develop the forecasts for the 2014 Business Plan, in case they demonstrate unexpected behavior of the model or features of the input data.

## 4  Conclusion

It is evident that a great deal of model development work has been completed within a very short timeframe. The initial Version 2 model results presented to the Panel during this period are considered to be an encouraging start, but a number of issues have been identified that must be addressed before work on calibration and validation can be completed or model application attempted.

Table 2: Model validation testing combinations

| Modeling system | Source of major model inputs | |
| --- | --- | --- |
| | 2030 Socioeconomic Data and Phase 1 Network | 2034 Socioeconomic Data and Phase 1 Network |
| Version 1 | 2012 Business Plan Model Run (already complete) | Validation test 2 |
| Version 2 | Validation test 1 | To be developed for the 2014 Business Plan |